# Checking Up on Tropical Sunlight

## Research Highlight

Science is not settled on a bet or a hunch. Measurements and data support conclusions and provide clarity. Scientists at Pacific Northwest National Laboratory (PNNL) found that about 10 percent of the time two ground-based stations on a tropical island, though less than five miles apart, collect different incoming sunlight measurements based on which way the breezes blow.

The comparison, using data from the Atmospheric Radiation Measurement (ARM) Climate Research Facility Madden-Julian Oscillation (MJO) Investigation Experiment (AMIE) field campaign and the ARM site on Manus Island in Papua New Guinea, confirmed the high quality and representativeness of the measurements taken at the ARM site.

"Our results show that the ground-based measurements at the ARM Manus site are representative of clouds in the region around the site and are less impacted by local island effects than other possible measurement sites on Manus," said Dr. Laura Riihimaki, PNNL atmospheric scientist and lead author of the study. "However, our analysis shows that caution should be used when comparing ground and larger-area satellite measurements during easterly wind conditions."

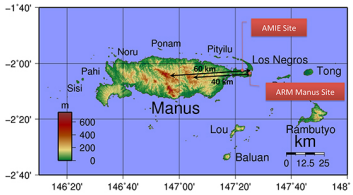
The PNNL team measured the surface irradiance and low cloud base height at a second site on Manus Island in the South Pacific, 7 kilometers (about 5 miles) inland from and slightly more elevated than the standard ARM measurement station at Papua New Guinea's Momote airport. From these measurements, they calculated the impact of clouds (cloud radiative effects, transmissivity, cloud fraction, etc.) using a radiative flux analysis code. They performed statistical comparisons under different wind conditions and found the greatest differences occur during easterly winds, when the inland site was downwind from the ARM site.

They found the ARM site had more frequent clear skies and a more consistent low cloud fraction under different wind conditions than the site further inland. When the inland site was downwind of the ARM site, there was an increased cloud occurrence, which happened approximately 10 percent of the time.

Under most conditions, the two sites' measurements agreed well: irradiance, cloud amounts, transmissivity, sunshine duration, and frequency of low cloud occurrence. However, they found a greater difference in cloud radiative effects during easterly wind conditions than other times. Further, when comparing over a year of broadband surface irradiance and ceilometer measurements, the Manus site is less impacted by the island meteorology than slightly inland. Derived quantities at the standard Manus site and a second location were also compared.

Sunlight energy in, energy out—it is the basis for the Earth's energy budget. Scientists calculate the incoming and outgoing sunlight energy using ground- and satellite-based measurements to better understand how this energy is soaked in by the surface or reflected back into space. When it is cloudy, less of the sunlight energy reaches the Earth's surface. Ground-based measurements are used to test satellite and computer model simulations of the surface energy budget. But, comparing surface irradiance (sun in, sun out) to satellite observations or model simulations can be like comparing apples to oranges. Knowing the difference between the two points of observation, researchers can judge the bias in either set of measurements to better gauge how well each captures the Earth's energy budget over a region or the globe. The information ultimately leads to better understanding of the Earth's climate.

The radiometer system used at the inland site for the study on Manus Island. Photo courtesy of ARM Climate Research Facility.




Manus Island, showing locations of the AMIE site instruments, and the ARM Manus site instruments as well as the island's significant orographic land features. Photo courtesy of ARM Climate Research Facility.

**Reference(s)**

Riihimaki LD and CN Long. 2014. "Spatial variability of surface irradiance measurements at the Manus ARM site." Journal of Geophysical Research – Atmospheres, 119(9), 5475-5491. ACCEPTED.

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Cloud Life Cycle